Analysis of Cinder Cones and Volcanic Ridge in the Adare Basin Antarctica

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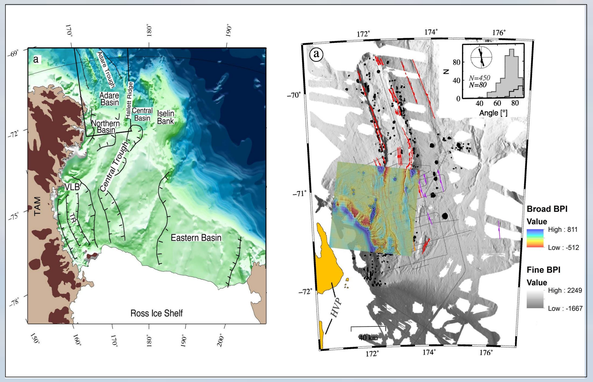
Introduction

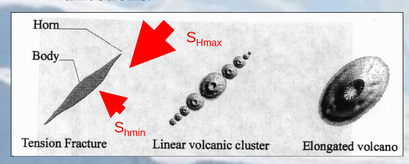
- Adare Basin, Antarctica, is a Paleogene-Neogene rift basin located in the West Antarctic Rift System.
- A volcanic ridge was identified in the region but its volcanic structure has never been researched in detail.



Location of research area off the coast of Antarctica in the Adare Basin, elevation and regional structure.(Granot et. al. 2007) Superimposed bathymetric map of research area.

Objectives

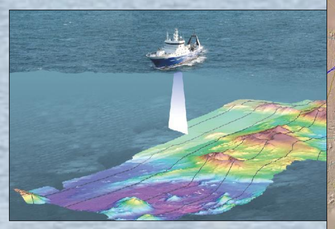
- Analysis of the submarine volcanic ridge dimensions and comparison to regional fault orientations.
- Analysis of volcanic cones associated with the ridge system to determine fissure orientation and horizontal stress directions.

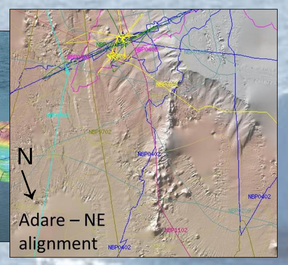


Orientation of crustal stresses relative to volcanic fissures. (Adiyaman et. al. 1998)

Data

- Data collected by the R/V Nathaniel B. Palmer with multibeam sonar to get a digital elevation model of the seafloor.
- Bathymetric Data downloaded from Marine Geoscience Data System via GeoMapApp and supplemented with data from the International Bathymetric Chart of the Southern Ocean via IBCSO.org

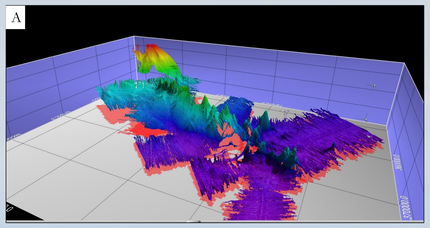


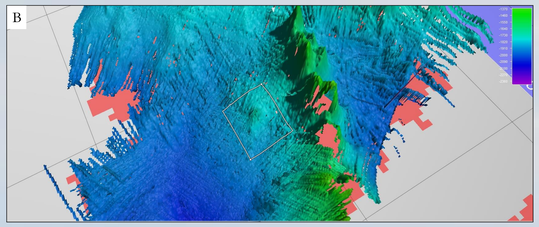


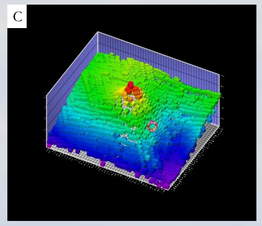
Left: Image of ship using multibeam sonar to acquire bathymetric data. (www.NIWA.co.nz)
Right: shows the cruise paths for the R/V Nathaniel B. Palmer that collected the multibeam sonar for this research. (Marine Geoscience Data System)

Methods

- Multibeam bathymetric data were converted and edited using DMagic and Fledermaus 3D editing software.
- High resolution multibeam and low resolution IBCSO 3-D data were then merged into one digital elevation model.
- Data were converted into ASCII format for use with ESRI ArcGIS to determine ridge outline and break in slope for individual cinder cones using the Benthic Terrain Modeler tool (http://www.arcgis.com/home/item.html?id=b0d0be66fd33440d97e8c83d220e7926) to create broad and fine Bathymetric Pixel Indices and hillshade models.
- Analysis of the data to determine the average break in slope was done by exporting the data from ArcGIS to excel and plotting elevation data allowing for a rise over run analysis to get slope.



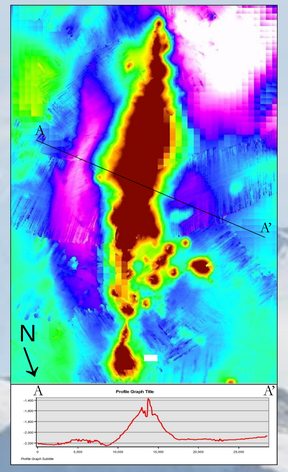


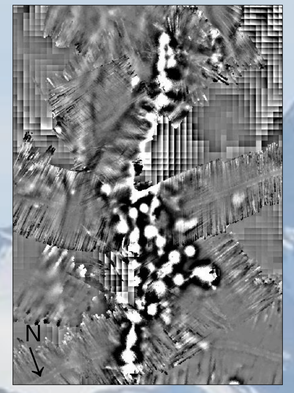


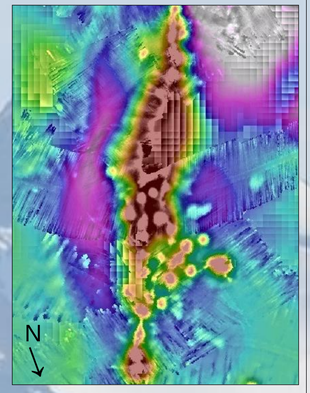
From left to right: Image of the multibeam sonar data visualized in 3-D with the Fleudermaus program (gaps in data later supplemented by coarser IBCSO data). Editing tools within the program allow for viewing individual sections of the data to enhance the image through removal of anomalies. The highlighted region in image B is broken down into cubes in image C allowing for the removal of anomalous high or low elevation points resulting in a cleaner image prior to mapping with ArcGIS software.

Observations/Results

Bathymetry of Volcanic Ridge



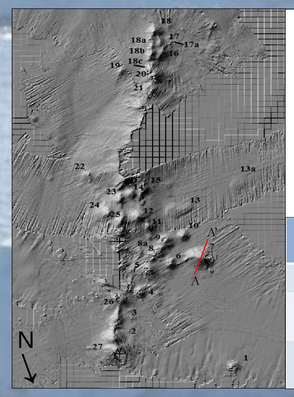


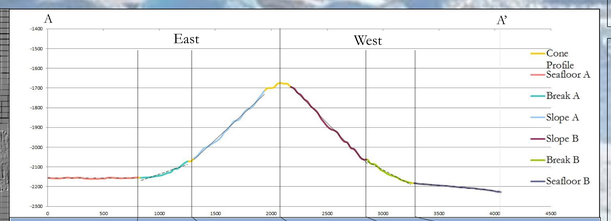


Upper Left: Broad Bathymetric Pixel Index (BBPI) of ridge system.
Left: Cross section from A-A' (~2.8 km) of the ridge.
Upper Center: Fine Bathymetric Pixel Index (FBPI) of ridge system.
Upper Right: Superimposed FBPI at 50% transparency onto the BBPI map.

- A Broad Bathymetric Pixel Index (BBPI) analysis of the data using the benthic terrain modeler tool displayed the overall shape of the ridge
  - Along the eastern flank of the ridge is a depression possibly due to crustal flexure associated with the ridge growth.
  - When the FBPI is overlain on the BBPI it displays the relief of the individual cones.
  - The FBPI/BBPI overlay also revealed that the ridge is segmented, shown by alignment of cones, not a continuous ridge.
  - There are cone alignments away from the major ridge that require more investigation.
  - The FBPI also displays the presence of elongated individual cones indicating a stress versus strain relationship that requires further analysis.

Slope Analysis



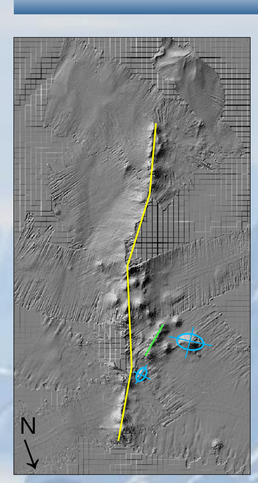


	East Apron	East Flank	West Flank	West Apron
Average Rise/Run	0.1797004641	0.4559610480	0.4996380594	0.1984427327
Average Degree	10.16	24.38	25.75	11.18

Left: Numbered locations of cones along the ridge system.
Upper Right: Sample profile of cone 7. Data was exported from ArcGIS to excel to create a profile for analysis.
Lower Right: The average rise/run and average slope angle of the 31 analyzed cones.

- Profile analysis shows a flank angle between 24-26 degrees and apron angle between 10-11 degrees on average.
- Slope analysis of the individual cones revealed a symmetrical cone shape with slightly steeper flank angles on the western side

Future Steps



- Complete a break in slope analysis Perform similar analysis with to define a shape of cone basis.
- Analysis of elongate cones to determine stress versus strain relationship.
- Analyzing the ridge and cone orientation data to compare with regional fault geometry of Adare Basin.

Yellow: The possible orientation of the fissures below the ridge as indicated by the ridge crest line.
Green: Potential associated fissures indicated by cinder cone alignments.
Blue: Clear elongate cones which can indicate stress direction.

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